ABSTRACTS FROM ASTRONOMICAL PUBLICATIONS.

Measurement of the Change in Gravity Caused by the Moon.

The diminution in the gravitation constant due to the position of the Moon had never been directly measured until the investigations of Schweydar, described in the present abstract (W. Schweydar: Änderung der Intensität der Schwerkraft durch den Mond, Sitz. kön. pr. Akad. d. Wiss., April, 1914), tho indirect evidence of the extremely minute change involved had been secured thru pendulum experiments. The paper is of great interest to the astronomer or geodesist, not only because it affords a direct confirmation of a point in gravitational theory and additional evidence bearing upon the question of the Earth's effective rigidity, but also because it is an excellent example of an experiment carried out with exceedingly simple instrumental means. For the instrument used, Schmidt's gravimeter, is so simple in its essentials that it could doubtless be rigged up in a few hours in any small laboratory. It consists of a disk about two and a half inches in diameter, provided with two small hooks at points 180° apart; fastened to the middle of the disk on the under side is a small weight of about twelve ounces. The disk and attached weight are suspended in a long glass jar by means of a spiral spring of steel wire somewhat over thirty inches long. To the two small hooks are attached two very fine wires, the other ends of which are fastened to the walls of the glass vessel at opposite points, somewhat above the plane of the disk. These wires support a very small fraction of the weight of the disk. If now the long spiral spring is twisted slightly at its upper end the disk will be slightly rotated, so that the two fine wires no longer lie in the same plane, and in this position the apparatus is extraordinarily sensitive to a small change in the weight of the disk; any such small change in weight will operate to rotate the suspended system slightly, a rotation which can be read off from a beam of light reflected from a small mirror attached to the suspended system.

So sensitive is the gravimeter that it was necessary to place it in an underground chamber eighty feet below the surface,

where it has been found that the temperature varies but 0°.2 per year, and the records were made by photographic means, inasmuch as the heat radiated from the body of an observer entering the subterranean chamber would affect the records for several hours. The apparatus, furthermore, acted as a pretty fair barometer; tho the suspended parts displaced less than two cubic inches of air, the difference in the buoyancy of even this small amount of air at different barometric pressures showed very clearly and had to be allowed for; even very minute, short-period oscillations in pressure as shown by a very sensitive barometer were recorded!

The observations extended over a period of 295 days and agree well with other investigations in placing the effective rigidity of the Earth as two or three times that of hardened steel.

The results, in combination with pendulum data, afford a method for determining the actual heights of the lunar tides caused in the elastic Earth; the maximum amplitude of this half daily tide in the solid Earth is about four and a half inches at Potsdam. H. D. CURTIS.

A "PERTURBATION MACHINE."

The tidal theory is one of exceeding complexity, and into it enter a multitude of interacting components of widely different magnitudes and periods, yet we know that all the varying effects of appreciable influence can be taken account of and combined into a single tidal curve by that ingenious mechanism known as the tide-predicting machine. We have the tidal machine and the harmonic analyzer as examples of what can be done by mechanical means in the solution of problems of great complexity, but, even with such examples before us, the mere idea that a machine is possible which should solve mechanically the question of the perturbations of a planet over long periods of time is something of a strain on the credulity of any who realize how complicated are the mathematical processes and how extended are the computations involved in this department of celestial mechanics. At the present rate of discovery it will be only a few years before the number of minor planets known will pass the thousand mark, and the labor of "keeping track"

of the orbits of all these objects has already become so great that it has been more than once suggested that the only possible course for the astronomical world is to admit itself beaten, let the less interesting members of the asteroid family drift into oblivion, and keep track of the perturbations and orbits of only a few of the more interesting planetoids. If, on the other hand, we are not to neglect any of these bodies, something in the nature of a "perturbation machine" would seem to be an absolute necessity.

The plan and preliminary specifications of such a "perturbograph" have been drawn up by SUNDMANN, the clever Finn whose brilliant work on the "Problem of Three Bodies" seems to have opened a new chapter in celestial mechanics; his name is sufficient guarantee that all the essential factors in this com plex problem have been taken into account ("Plan d'une Machine destinée à donner les Perturbations des Planètes," par KARL F. SUNDMANN, Särtryck ur Festskrift Tillegnad ANDERS DONNER, Helsingfors, 1915). It was SUNDMANN of whom Sir GEORGE GREENHILL said in a Presidential Address to the Mathematical Association (quoted from *The Observatory*, Aug. 1915):—

"No sooner had POINCARÉ declared the Problem of the Three Bodies insoluble than SUNDMANN showed how the divergency of the series required to hold for infinite eternity of Time, past and future, could be cured by a simple change of the variable."

The machine has not yet been constructed. This brochure is devoted solely to a general description of the plans for such a machine, with schematic drawings of the various portions; from these it is very difficult to get an idea of the machine in its entirety or to see in just what way the various portions are combined. Suffice it to say that the machine will be very complicated, apparently so much so that a tide-predicting machine appears by contrast to be a relatively simple mechanism. To quote SUNDMANN's general description of the machine and its functions:—

(1) A mechanism imitates the movements of the perturbing and perturbed planets in such a manner that their relative positions in space are indicated upon the scale given by the relative positions of certain elements of the machine.

(2) According to the relative positions of these elements, other elements are constrained mechanically to indicate by their relative positions the magnitudes of the perturbing forces, and according to the position of this second set of elements, a third set indicates the derivatives of the perturbations.

(3) By combining these final elements with integrators, the perturbations are obtained, which are recorded at the desired epochs.

(4) As the registered perturbations increase in the machine, the position of the perturbed planet is to be automatically corrected for the values of the perturbations.

The author states it as his belief that the perturbations can be secured by such a machine, accurately constructed, to within less than one per cent of their magnitude.

His plan is to give a speed of movement to the perturbograph such that one revolution of *Jupiter* would take about seven minutes, so that an interval of ten days would correspond to one second. The setting up of the instrument would take about twenty-five minutes, if made by two persons. With the aid of proper auxiliary tables it should be possible to determine the perturbations for all the oppositions during a revolution of *Jupiter*, i. e., for about twelve years, in one hour.

It is to be hoped that the author may find it possible to proceed to the construction of the ingenious machine which he has devised. Tho its first cost might be considerable, it would perform in a short time the work now laboriously executed by large staffs of computers in connection with the ephemerides of the asteroids. H. D. CURTIS.

TEMPERATURE AND THE FORCE OF GRAVITY.

In a letter to *Nature*, **96**, 143, entitled "*The Masses of Heavenly Bodies and the Newtonian Constant*," Dr. P. E. SHAW of the University College, Nottingham, questions the constancy of the Newtonian gravitational factor G. He believes, as the result of certain experiments by himself, that the gravitational force exerted by a mass at a constant distance varies with its temperature. Quoting a passage from Dr. SHAW's letter:—

"I have recently concluded a long research on the value of G up to 250° C., and I have found an increase in that 'constant' of about 1 in 10.5 per 1° C. The full results I hope to publish shortly."

The letter devotes itself chiefly to a consideration of the influence of the proposed generalization of the law on the computed values of the masses of the Sun and planets.

Effects such as the one Dr. SHAW believes he has found have been sought by earlier investigators with negative results. His extension of the law of gravitation, if established, would be so far-reaching in its influence that its importance could hardly be over-estimated. It is to be hoped that the complete account of his experiments may soon be forthcoming.

W. H. W.

A FAINT STAR OF LARGE PROPER MOTION.

Mr. R. T. A. INNES has been one of the most energetic advocates of the merits of the blink-microscope "in picking out unusual motions or objects upon a pair of plates. In Circular No. 30 of the *Union Observatory* he gives a new example of the value of this instrument which has resulted from the comparison of two photographs of the region around *α Centauri*, taken at dates separated by 5.3 years. A small star was found, 2° 13′ from *α Centauri*, which has a proper motion of about 5″ annually. The precise value is slightly in doubt because the images on one of the plates are not very satisfactory. Only five stars are known whose proper motions exceed this value, and all of them are much brighter than this star, which has a photographic magnitude of 12.0 on the Harvard scale. Visually the star appears to be about tenth magnitude. Its position for $1900 + t$ is given as R. A. $14^h\ 22^m\ 55^s - 0^s.65\ t$, Decl. $-62°\ 1'.6 + 1''.6\ t$.

R. G. AITKEN.